Owing to the radiation of the surfaces from a common vertex and the steps which occur between the vertex and the base, the angle of the conical surface of the stone is greater near the vertex than near the base. Thus the smaller stones appear less elongated than those which are larger.

The fact that in the sketches of actual stones, which I gave in my last paper, I showed the steps as less pronounced and the angles larger than they are in the artificial stones, is probably owing in some measure to my having formed my ideas from the observation of favourable specimens chosen from amongst those which fell. The larger angles were probably also, in part, owing to the smaller size of the actual hailstones, which were not much more than one-fourth of an inch across. But I think that it is important to notice that the somewhat imperfect way in which the outside layers in the surface of the artificial stones are continued, may be owing to the narrowness of the jet of air which, on striking the stone, tends to diverge laterally rather than to flow upwards past the sides of the stone, as it would do if the jet were broader, or as the air must do when the stone is falling through it.

The rate at which stones can be formed depends on the amount of water which can be introduced into the spray, the larger stones taking from one to two minutes. At first sight this may seem to be somewhat slow, but the following estimate tends to show that the artificial are probably formed quicker than the actual stones.

The speed of the jet of air at the point at which the stones are formed is nearly equal to that at which the larger stones would fall through the air. This is shown by the fact that if a large stone becomes accidentally detached from its splinter of wood it rather falls than rises, but when this happens with smaller stones they are driven up by the force of the blast.

I find that the speed of the blast varies from 150 to 200 feet per second, *i.e.*, from one-and-a-half to two miles a minute. The larger stones, therefore, traverse from one to four miles of frozen spray. So that if we imagine a cloud as dense as the spray it would have to be from one to four miles thick in order that the stones might, in falling through it, attain the size of the artificial stones; and considering that the stones would only gradually acquire a speed equal to that of the blast, the time occupied in falling through the cloud would in all probability be very considerable, at least from five to ten minutes after the stone had acquired a sensible size.

As regards the proportion which the density of spray bears to that of a cloud, a comparison may be made from the fact that when working in saturated air at a temperature of 60° or 70° F., the condensation of vapour supplied sufficient ice to form the spray; and since it is probable that the dense summer clouds, from which hail is formed, result from the cooling of air from temperatures nearly, if not quite, equal to this, there is probably no great difference in the density of the clouds and the spray.

I have not yet had an opportunity of examining the texture of these stones under the microscope, but to all appearance they consist of an aggregation of small spherical particles of ice; and it seems worthy of notice that while nothing like a snow crystal ever appears to be produced in the ether spray, the moment the blast is stopped the end of the ether tube becomes covered with ice, which often assumes the form of snow crystals.

This appears to indicate the character of the difference between those conditions which result in snow and those which result in hail.

When the cloud-particles are formed at or above the temperature of 32°, and then freeze, owing to cooling by expansion or otherwise, the particles as they freeze retain their spherical form. This is what happens in the spray.

On the other hand, when saturated air at a temperature below 32° is still further cooled, the deposition of the vapour will be upon ice, and will take the form of snow crystals.

The aggregation of the snow crystals into flakes is, as I pointed out in my previous paper, accounted for by the larger crystals overtaking the smaller crystals in their descent, and the still more rapid descent of the flakes as they increase in size.

As regards the formation of rain-drops, I have nothing to add to what was contained in my last paper. The same explanation obviously applies to both hail and rain; and any doubt which may have been left by the less direct arguments in my former paper will, I venture to think, have been removed by the verification of my predictions in the production of artificial hailstones so closely resembling in all particulars those formed by nature. And, in conclusion, I would thank Dr. Crompton for the suggestion of the means by which I have been able to produce these stones.

OUR ASTRONOMICAL COLUMN

THE SOUTH POLAR SPOT OF MARS.—Prof. Asaph Hall has instituted a series of measures of the position of the south polar spot of Mars, with the Washington refractor during the late favourable opposition of the planet, having been led thereto by the great discordances in the positions of the spot, as determined so far. He adopts Oudeman's node and inclination of the equator of Mars, which, for the epoch taken, viz., 1877, September, 17·0, G.M.T. give $N = 47° 56'$, $I = 39° 14'$, and the angle of position of the south pole 162° 6', and assumes the time of rotation of the planet 24h. 37m. 22·73s., as found by Mr. Proctor. The observations were made with a power of 400, and on thirty-two nights, from August 10 to October 24, during the whole of which period the spot was always seen with great distinctness, and little change in its appearance noted except what might be accounted for by change of distance. From thirty-four equations of condition treated on the method of least squares, Prof. Hall finds for the angle of position of the south pole of Mars at the above-mentioned epoch 166° 22', for the radius of the small circle described by the spot 5° 11', and for the angle of position of the spot at the epoch, with respect to the rotation-axis of the planet, 311° 24'. The various determinations of the south polar distance of this spot are as follow:—

	°	'		°	'
Herschel, 1783 ...	8	8	Linsser, 1862	20	0
Bessel, 1830	8	6	Kaiser, 1862	4	16
Mädler, 1837	12	0	Hall, 1877	5	11
Secchi, 1857	17	42			

On several of the finer nights, when the markings on the edge of the spot were very distinct, it appeared as "a depression in the surface of the planet."

PROF. NEWCOMB'S LUNAR RESEARCHES.—It is understood that if no unforeseen delay occurs in the printing, Part I. of "Researches on the Motion of the Moon," upon which Prof. Newcomb has been engaged for six years past, will be ready for publication in the course of next month. It is devoted to the discussion of eclipses and occultations previous to 1750. An abstract appeared in *Silliman's Journal* for November last.

THE CORDOBA OBSERVATORY.—In an address delivered on November 4, on the occasion of receiving from the Governor of the province of Cordoba the premiums awarded at the Centennial Exhibition in Philadelphia to the Argentine National Observatory and to himself for Lunar and Stellar Photographs, Dr. B. A. Gould gave a brief outline of the successive applications of photography to astronomical purposes since Mr. Bond's experiments with the 15-inch refractor of Harvard Observatory in 1850, with more particular reference to work executed at Cordoba of late in this direction. Dr. Gould expresses

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himself satisfied with the results obtained at the Argentine Observatory; the photographs of the moon at full and in the last quarter he thinks may be favourably compared with any obtained elsewhere which he had seen. He refers to "the very beautiful picture of the moon" made with the 4-feet reflector at Melbourne, which was also exhibited at Philadelphia, and adds, he is not sure, if he had seen this elegant photograph before placing his own on exhibition, he would have ventured to compete. Dr. Gould remarks that much of the credit of the stellar photographs is due to the pure air of Cordoba, which is incredibly transparent on the not very numerous occasions when the sky is really clear. The impressions on glass exhibited were of six different clusters, the plate of the cluster X Carinæ containing two images each of 185 stars, and that of η Argus containing 180, and many of the stars as faint as the ninth magnitude. Measurable photographs of not less than eighty-four celestial objects have been secured, of which nineteen are double stars and the remainder clusters. The planets Jupiter, Mars, and Saturn, have also been photographed "with sufficient distinctness to show clearly the details of light and colour on the surfaces of the two former, and the existence of the ring in the latter," but the images have not been sufficiently sharp to allow of successful photographic enlargement.

VARIABLE STARS.—Herr Palisa in *Ast. Nach.*, No 2,174, mentions his having remarked a new variable star, the position of which for 1877·0 is in R.A. 16h. 4m. 35s., N.P D. 109° 48'·9. It does not occur on Chacornac's chart No. 49; it was 10m. on May 26, 1876, and on July 31 and August 3 of last year, whereas on May 17, 1877, no trace of it was perceptible. The period is therefore no doubt comparatively short.

The star L. 36606 = B.A.C. 6641 appears to vary from 6·5m. to 9m. On October 17, 1852, Argelander estimated it of the former magnitude, Lalande and Piazzi call it an eighth, while about midsummer, 1851, it was little, if anything, over the ninth magnitude.

L. 26211 is probably variable from 6m. to 8m., and L. 27307 from 7m. to 9m., and it is not unlikely that further observations will place δ^2 Geminorum on the list of variables; it has been rated at a fifth magnitude and as low as $8\frac{1}{2}$.

THE MINOR PLANET EVA.—A planet of the eleventh magnitude, observed by Herr Palisa at Pola on December 29, is mentioned in the *Bulletin International* of January 3, as possibly No. 180, but according to a communication from Herr Knorre, of Berlin, as probably identical with No. 164, detected by M. Paul Henry at Paris on July 12, 1876, which received the name *Eva*. The observations of 1876 extended over an interval of little more than a fortnight, and the elements which have been calculated by Mr. Winslow Upton and M. Bossert are therefore liable to uncertainty, but if we adopt Mr. Upton's orbit and compute for the time of the Pola observation, the place is found to be about a degree only from that observed, and it is therefore probable that No. 180 has yet to be discovered.

THOMAS VERNON WOLLASTON

THE very limited band of scientific English entomologists has just suffered a great loss by the sudden death, on the 4th instant, at his residence, 1, Barnepark Terrace, Teignmouth, of Thomas Vernon Wollaston—a name dear to science, and of which he well upheld the reputation. Accurate, elaborate, and precise *ad punctum*, and naturally of a minutely critical habit, he nevertheless persistently acted upon a broad conception of the science to which he was devoted; and taking advantage of the periodical banishments to a warmer climate imposed upon him in early manhood by pulmonary weakness, set himself the task of thoroughly investigating the coleopterous fauna of the Madeiras, Salvages, and Cape de Verdes, and finally of St. Helena. His philosophical deductions from the vast mass of well-sifted evidence obtained (chiefly by his own bodily toil, though he was always in a more or less debilitated state of health) referring to these isolated groups, may be summed up as corroborating the former existence of that submerged Atlantis whereon geologists differ. From the exhaustive care with which his material was obtained, it seems highly unlikely that his premises were insufficient; and his discussion of the subject so far resembles Mr. Darwin's method that it supplies the objections likely to be raised, and itself practically exhausts criticism by minuteness of observation.

To students of British entomology, Mr. Wollaston is best known by his early papers in the *Zoologist* and Stainton's *Entomologists' Annual and Weekly Intelligencer*, and by his revision of *Atomaria* in *Trans. Ent. Soc.*, 1877 His first scientific contribution was in the *Zoologist*, vol. i. (1843), on *Coleoptera* at Launceston, when a student at Jesus College, Cambridge (where, with the late J. F. Dawson and Hamlet Clark, he imbibed from Dr. Babington a taste for natural science), and his last, a paper in the *Annals and Magazine of Natural History*, on a weevil destructive to the banana in Madeira, was received from him by the writer almost simultaneously with the news of his death. He published many descriptive and analytical papers, almost exclusively on *Coleoptera*, in the above-named publications, the *Journal of Entomology* and the *Entomologists' Monthly Magazine*; but his *magnum opus* is the well-known "Insecta Maderensia," published in 1854, the results of his sojourns in Madeira, to which he first went in 1847. This, from its amount of novelty and classical treatment, at once established his reputation.

His collection, increased by another visit in 1855, having been purchased by the trustees of the British Museum, he prepared a more complete account, which was published as a museum "Catalogue" in 1857. Subsequent visits in 1858 and 1859 resulted in a description of the coleopterous fauna of the Canaries, also published as a museum "Catalogue" in 1864. The acquisition of fresh material compelled him in the next year to write his "Coleoptera Atlantidum," an arduous critical work of nearly 700 pages, followed in 1867 by the "Coleoptera Hesperidum," a valuable descriptive account of the species of the Cape Verde Archipelago, visited in 1866. His last contribution to geographical entomology, "Coleoptera Sanctæ-Helenæ," 1877, contains a multiplicity of unexpected developments (especially after the supposed exhaustion of the productions of the island in Mr. Melliss's work), and shows that St. Helena is the home of a special family, *Cossonidæ*, to which Mr. Wollaston had always devoted attention, having himself described no less than 255 new species in it, as against 67 described by all other naturalists, living or dead.

Of his other works, it may suffice to mention one on the "Variation of Species," published in 1856, and another, "Testacea Atlantica," that will, alas, be posthumous (though complete), being a descriptive account of the land-shells of his favourite hunting-ground.

The amount of work in these publications and in others not referred to, is astonishing, especially to those who know the extreme precision (both in manipulation and writing) and the weak physical condition of the author. Mr. Wollaston became a Fellow of the Linnean Society in 1847, and was also a Fellow of the Cambridge Philosophical Society, but, beyond his university degree, sought no other honorary distinction. He was, we believe, in his fifty-seventh year at the time of his death. E. C. R.

NOTES

WE may remind our readers that on this day, a century ago, one of the great reformers of science—perhaps the most celebrated naturalist of all times—Linné, breathed his last. His

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